

Syntheses of boron-doped polycrystalline diamond on molybdenum substrate for cold discharge cathode

Hiroaki Yoshida, Isamu Yanase, Naoshi Sakuma, Tomio Ono and Tadashi Sakai

Corporate Research and Development Center, Toshiba Corporation

Keywords: polycrystalline diamond, cold discharge cathode, trimethyl borate, microwave plasma CVD

Abstract

Diamond is considered as a promising candidate for the cold discharge cathode material due to large ion-induced secondary electron yield and good resistance to sputtering. In this paper, we report growth condition of boron-doped polycrystalline diamond film on molybdenum substrate and fundamental discharge characteristics of the film.

We have proposed to apply diamond as a cold cathode material to reduce the electric power consumption of cold cathode discharge lamps (CCFL). For the CCFL application, it is important to grow diamond films controlling conductivity on an applicable cathode substrate material. In this research, we selected molybdenum (Mo) as the substrate, and tried to grow boron-doped polycrystalline diamond films on that by microwave plasma CVD.

The Mo substrate was pretreated by inorganic acid, and then the bias-enhanced nucleation (BEN) was performed in the CVD chamber. To grow diamond layer, we used acetone and trimethyl borate mixed solution as carbon (C) and dopant boron (B) sources. B/C ratio was easily varied by mixing ratio of solution, and vapor of the solution was carried into the chamber with hydrogen. Growth time was 2 hours, microwave power was 1.5kW, and substrate temperature was 850 °C approximately. The resulted film thickness was about 4 μm, and B concentrations in the layers was found to between 1017 and 1020 /cm³ from SIMS measurements.

Glow discharge characteristics of the film were evaluated in argon (Ar) ambient gas with open-cell regime. Cathode fall voltages (V_c) were measured both for hydrogen-plasma and acid treated surface conditions. The corresponding V_c were 70 V and 90 V, respectively. These values were significantly low compared to that of conventional metal cathodes (140V). It was confirmed that B-doped CVD poly-diamond films could be a new cold cathode material candidate for discharge lamps.

This work has been performed as a part of the Advanced Diamond Device (ADD) project, which is supported by METI through NEDO.